UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
Science and Ecosystem Support Division
Field Services Branch
980 College Station Road
Athens, Georgia 30605-2720

September 16, 2015

4SESD-FSB

MEMORANDUM

SUBJECT: Technical Assistance Report
The Pasion River Fish Kill Investigation
SESD Project # 15-0383

FROM: Jairo Castillo, P.E.
Enforcement Section

THRU: Mike Bowden, Chief
Enforcement Section

TO: Ruben Aleman,
CAFTA-DR Environmental Specialist & Industrial Enforcement Section
US Agency for International Development (USAID)/El Salvador

Please find attached the Technical Assistance Report for the Pasion River Fish Kill Investigation. The visit was conducted on July 6-9, 2015. EPA has not yet received the surface water sample analytical results from the sampling activities conducted on July 7, 2015. In addition, EPA is also waiting for technical documentation related to the fish sampling protocols performed during the fish kill investigation and fish tissue toxicity analytical results.

As stated in the attached report, EPA strongly recommends MARN to continue the water quality monitoring of the Pasion River, especially nearby the residential community areas that use surface water and conduct fishing activities for human consumption. Again, EPA appreciates the opportunity to assist a fellow country in environmental challenges as the one that Guatemala just experienced. Please contact us at (706) 355-8621 or at Castillo.Jairo@epa.gov if you have any questions or comments.

Attachment

United States Environmental Protection Agency
Region 4
Science and Ecosystem Support Division
980 College Station Road
Athens, Georgia 30605-2720

Technical Assistance Report

The Pasion River Fish Kill Investigation
Sayaxche, El Peten, Guatemala
Inspection Date: July 6-9, 2015
SESD Project ID No. 15-0383

Requestor: Ruben Aleman
Climate Change and Pathways to Prosperity/
CAFTA-DR Environment Specialist
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SESD Project Leader: Jairo Castillo, P.E.
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U. S. EPA Region 4
980 College Station
Athens, Georgia 30605-2720

Title and Approval Sheet

Title: USEPA Technical Assistance for the Pasion River Fish Kill Investigation
Sayaxche, El Peten, Guatemala

Approving Official:

Mike Bowden, Chief
Enforcement Section
Field Services Branch

9/16/15
Date

SESD Project Leader:

Jairo Castillo, PE, Environmental Engineer
Enforcement Section
Field Services Branch

9/16/15
Date

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Sayaxche, El Peten

1 Introduction

During the week of July 5, 2015, representatives of the U.S. Environmental Protection Agency, Science and Ecosystem Support Division (USEPA – SESD) provided technical assistance to the Guatemala Ministry of the Environment and Natural Resources ("Ministerio Del Ambiente y Recursos Naturales", MARN). The objective of the technical assistance was to support the investigation of two fish kill events that took place in The Pasion River, El Peten Department, in Guatemala. The technical assistance was performed at the request of the US Agency of International Development (USAID), under the existing Inter Agency Agreement with USEPA supporting the environmental obligations of the US-Central America Free Trade Agreement (CAFTA-DR)

The following personnel participated in the technical assistance:

Name	Organization	Telephone
Jairo Castillo	USEPA–SESD, Env Engineer	(706) 355-8621
John Ruiz	USEPA–SESD, Biologist	(706) 355-8725
Jose G. Castañeda	MARN, Supervisor	(502)-5802-0297
Carlos Mazariegos	MARN, Lead Inspector	(502)-5189-8234
Lizandro D. Hernandez.	MARN, Inspector	(502)-5452-8276
Herson Ochoeta	MARN, Biologist	(502) 5710-4543

2 Background

During the first week of May 2015, MARN was notified about a fish kill in the Pasion River. The Environmental Unit of the Municipality of Sayaxche recommended that no fish should be consumed from the impacted river and that the waters of the river should not be used for human consumption. During the week of June 1, 2015, a second notification was made to MARN concerning a new fish kill event that also took place in The Pasion River. Approximately sixteen communities were affected and more than 100 kilometers of the river were impacted. The impact of the fish kill was of such magnitude that was declared an ecological disaster by MARN. Preliminary sampling results for toxic pollutants in the river showed concentrations of Malathion in the river. Malathion is an organophosphate (OP) insecticide that is used in agriculture, residential gardens, public recreation areas, and in public health pest control programs (USEPA, 2015). Three companies located within the river banks that produce African palm oil were identified as suspected responsible parties for the fish kills.

On June 11, 2015, a press release from "Prensa Libre" newspaper stated that Tranquilino Xojalaj, administrator of the Reforestadora de Palmas El Peten, S.A. (REPSA), which is one of the suspected responsible parties, declared that heavy rain caused the oxidation lagoons to overflow into the river. REPSA also denied any involvement in the disaster, stating that they do not use Malathion as a pesticide.

During the first week of June 2015, the MARN's Department of Hydrological Resources and Watersheds conducted a sampling inspection in the impacted areas, including site inspections to the following African palm tree oil production industries: Reforestadora de Palmas de El Peten (REPSA I & II), Palma Sur, S.A., and Nacional Agro Industrial, S.A. (NAISA). The purpose of the June inspections was to review the facilities compliance with the wastewater reuse requirements under the Government Agreement (GA) No. 236-2006: *Discharge and Reuse of Wastewater and Sludge Disposal Regulations*, issued by MARN. Samples for nutrients (total nitrogen and phosphorus), biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total suspended solids (TSS), total metals, cyanide, oil & grease, pH, and temperature analyses were collected at each of the facilities' wastewater reuse discharge locations and other suspected areas that may have contributed to the Pasion River Fish Kill events. Samples collected were analyzed by the National Laboratory of Health of the Ministry of Public Health and Social Assistance, located in Guatemala City.

Analytical results for samples collected from REPSA I exceeded the discharge limits of Article 20 of the Agreement No. 236-2006 (pollutant limits for wastewater discharge into surface waters) for TSS and color. The analytical results for REPSA II exceeded TSS, total nitrogen, total phosphorus, pH, and color. In addition, the analytical results for Palma Del Sur, S.A. and Nacional Industrial, S.A. (NAISA) exceeded the discharge limits for TSS, total nitrogen, and color. Samples for fecal coliforms were not collected due to holding time restrictions. For more detail information, refer to MARN Report No. 27-2015/DRHyC.

Based on the Article 34 (Water Reuse Parameters) of the GA No. 236-2006, REPSA, NAISA, and Palma Del Sur, S.A. agricultural activities are classified as Type I: Water Reuse for General Agriculture Activities. The Article 34 (Type I classification) does not include limits for the pollutants described above when the wastewater is reused. However, if wastewater is discharged into the surface waters of the country, Article 20 will apply.

On July 7, 2015, the EPA team in conjunction with MARN's personnel conducted inspections at the REPSA I and REPSA II properties. As part of the inspection, **three surface water samples** were collected. One sample was collected from the Pasion River upstream from REPSA I and II facilities. This sampling location was used as the background sample in an effort to determine the water quality of the river upstream of the suspected responsible parties. A second sample was collected from the Machaquila River (tributary to the Pasion River) at a point downstream from REPSA II and upstream from REPSA I. A third sample was collected from the Pasion River downstream of REPSA I and II properties (See **Figure 2, page 9**).

3 Inspection Findings

As previously stated, the purpose of the visit was to support the MARN inspection and sampling activities, assess the conditions of the Pasion River impacted areas, and provide appropriate technical recommendations and suggestions. As part of the technical assistance, the following inspection was conducted:

Table 1: MARN Inspections

Inspection Type	Lead Agency	Facility Name	Inspection Date	Lead Inspector
Compliance Evaluation Inspection	MARN	Reforestadora de Palmas El Peten, S.A., REPSA I and II	July 7, 2015	Carlos Mazariegos

On July 7, 2015, MARN's inspectors contacted the Nacional Agro Industrial, S.A. (NAISA) to confirm an inspection scheduled for July 8, 2015. Site access was initially granted over the phone, but denied when the EPA and MARN arrived at the property. After the denial of entry, MARN started the legal process to acquire access to the NAISA property. According to MARN's inspectors, NAISA had not submitted an Environmental Assessment Instrument to MARN for evaluation. EPA also noted that the GA No. 236-2006 (Guatemala Discharge and Sludge Regulations) does not clearly describe the legal authority of a MARN inspector to access and inspect an entity regulated by this rule. Articles 42 and 51 describe the responsibility of MARN for monitoring compliance with the regulation, but do not clearly state the legal authority that the inspectors have to review the compliance of the entities to be inspected. This condition will negatively affect the ability of the inspectors to carry on their legal mission and therefore, it should be revised.

3.1 REPSA I Inspection Findings

On July 7, 2015 the EPA and MARN inspected the REPSA I facility, including the oxidation lagoon treatment system. This wastewater treatment system treats the wastewater generated from REPSA I palm tree oil processing. The system consists of five oxidation lagoons, which included cooling stabilization lagoons, anaerobic (an anaerobic lagoon is a deep impoundment, essentially free of dissolved oxygen that promotes anaerobic conditions (USEPA 2002)), and facultative lagoons, with each lagoon having a volume of approximately 3,500 m^3 (925,000 gallons). A facultative lagoon is earthen impoundment that the layer of water near the surface contains dissolved oxygen due to atmospheric reaeration and algal respiration, a condition that supports aerobic and facultative organisms, and the bottom layer of the lagoon includes sludge deposits and supports anaerobic organisms (USEPA, 2002). EPA observed that all lagoons were not sealed (no concrete, liner, clay, etc.), which may create suitable conditions for groundwater contamination.

During the EPA visit, it was observed that the REPSA I lagoons were almost full to capacity, with a free board of approximately one foot (0.3 meters) (See photo 1, page 17). Typically, lagoons should have a minimum freeboard of 0.9 meters (3 feet) (USEPA, 2002). The minimum freeboard design criteria is recommended in an effort to avoid or minimize overflow during rain events of significant magnitude. In addition, EPA and MARN detected a very strong hydrogen sulfide odor similar to rotten eggs originating from the lagoon treatment system. At the time of the inspection, REPSA I was discharging untreated anaerobic sludge through a 15-cm (6-in) bypass pipe from the bottom of the anaerobic lagoon into an open channel area (See photo 2, Page 17). This bypass practice may short-circuit the hydraulic flow of the treatment process and

consequently adversely impact the overall treatment of the wastewater. Typically in this type of system, higher concentrations of contaminants are found in the bottom of the lagoon. Consequently, the bypass was discharging potentially the highest concentrations of contaminants outside of the wastewater reuse system. According to MARN's inspectors, REPSA also had not submitted to MARN its Environmental Assessment Instrument to evaluate the environmental impacts of its operations in the area, including an evaluation of the criteria used for the design of the oxidation lagoons. Since REPSA only had authorization to reuse the treated wastewater in the authorized irrigation fields, then this type of practice violated the Government Agreement 236-2006, Articles 34 (Wastewater Reuse Parameters), 55 (Disposal Prohibition of Wastewater), and 56 (Direct Discharge Prohibition), and therefore, can be considered an illegal discharge.

EPA observed that the wastewater/sludge discharged from the bypass pipe was dark gray in color and had an oily like appearance. Refer to Photos 2 through 5, pages 17-19, for details. **Figure 1** shows the location of the anaerobic lagoon bypass and the direction of the wastewater/sludge discharge.

Figure 1: REPSA I Oxidation Lagoon Bypass Location

A dark brown, almost blackish wastewater/sludge is a sign of anaerobic conditions (low levels of dissolved oxygen) (USEPA, 1977). Wastewater generated from palm oil processing is also known as Palm Oil Mill Effluent (POME). POME, when fresh, is a thick brownish colloidal mixture of water, oil and fine suspended solids. It is hot (80-90^{0}C) and possesses a very high BOD_5, which is non-toxic as no chemicals are added to the extraction process (Khalid & Wan Mustafa, 1992; Ma et al. 1993). POME is also acidic with a pH of around 4.5 (Madaki, Seng, 2013).

EPA confirmed POME pH and temperature characteristics with in-situ measurements conducted in the REPSA I cooling lagoon influent section. Measurement results indicated a pH of 4.5 and

temperature was 80 °C. In addition, Eng. Edgar Moran (REPSA Facilities Manager) stated that the chemical oxygen demand (COD) concentration for POME generated at REPSA I was on average 41,000 mg/l. COD is a measure of the oxygen required to oxidize all compounds, both organic and inorganic matter, present in wastewater. Since COD measure the oxygen consuming capacity of both organic and inorganic matter in water, COD analytical results could be up to three times higher than the biochemical oxygen demand (BOD_5) analytical results.

BOD measures the amount of oxygen consumed by microorganisms in decomposing organic matter in stream water. A number of variables affect the rate of oxygen consumption in a stream: temperature, pH, the presence of certain kinds of microorganisms, and the type of organic and inorganic material in the water. BOD directly affects the amount of dissolved oxygen in rivers and streams. The greater the BOD, the more rapidly oxygen is depleted in the stream (USEPA, 2015). This means less oxygen is available to higher forms of aquatic life. The consequences of high BOD are the same as those for low dissolved oxygen: aquatic organisms become stressed, suffocate, and die (USEPA, 2015).The adverse impacts of POME discharges into water bodies had been well documented. Excessive quantities of untreated POME deplete a water body of its oxygen and suffocate aquatic life (e.g., fish kill, loss of macro invertebrates, etc.). Many large and small rivers have been devastated by such discharge as people living downstream are usually affected (Madaki, Seng 2013). In summary, the discharge of untreated POME with high temperature and high BOD concentrations will deplete the oxygen concentrations of the receiving water and consequently, negatively affecting the aquatic life. In addition, the POME's low pH levels will change the pH levels in the receiving waters, thus also impacting negatively the aquatic life.

3.2 REPSA II Inspection Findings

EPA and MARN also performed a walk-through to the REPSA II oxidation lagoon system. REPSA was expanding the lagoon system from nine lagoons to twelve new lagoons, for a total of twenty-one lagoons (See photos 6 through 8, pages 20-21). The system is composed of cooling lagoons, anaerobic and settling lagoons. The treatment system also included a 1,200 m^3 digester lagoon for anaerobic sludge treatment. New lagoons were constructed with a concrete foundation. Eng. Edgar Moran stated that the construction of the new lagoons started on May 2015 (approximately two months before the EPA-MARN inspection). At the time of the inspection, REPSA II was put out of line because of the fish kill investigation conducted by MARN. The facility transferred part of the REPSA I wastewater generated from the palm oil manufacturing process to the REPSA II oxidation lagoon system. REPSA as a whole is planning to expand the production of palm trees from 150 hectares to 300 hectares in the coming years.

4 The Pasion River Site Reconnaissance and Sampling

On July 8, 2015, EPA and MARN conducted a site reconnaissance on the Pasion River, near the cities of Sayaxche, El Ceibal, and Cedral. The river water appeared turbid. In addition, a large oil like sheen with debris was observed at the river water surface (See photo 9, page 21). EPA and MARN personnel observed sewage seeping from the ground and flowing directly into the Pasion River at the City of Sayaxche ferry area. (See photo 10, page 22). EPA also observed Sayaxche residents collecting water near the sanitary leaking area that reportedly will be used for some sort of human consumption (See photo 11, page 22).

4.1 The Pasion River Sampling Activities

MARN collected three surface water samples from the Pasion River (See **Figure 2, page 9**). Samples were collected for BOD_5, chemical demand oxygen (COD), TSS, metals, phosphorus, total nitrogen, oils and grease, fecal coliforms, total cyanide, and color analyses. Analytical results were not available at the time of the completion of this report. Upon completion of the analytical results, the results and their interpretation will be provided in an additional report. **Figure 2** describes the sample locations. **Table 2** includes the EPA field measurements collected in the three sampling locations.

Figure 2: The Pasion River Sample Locations

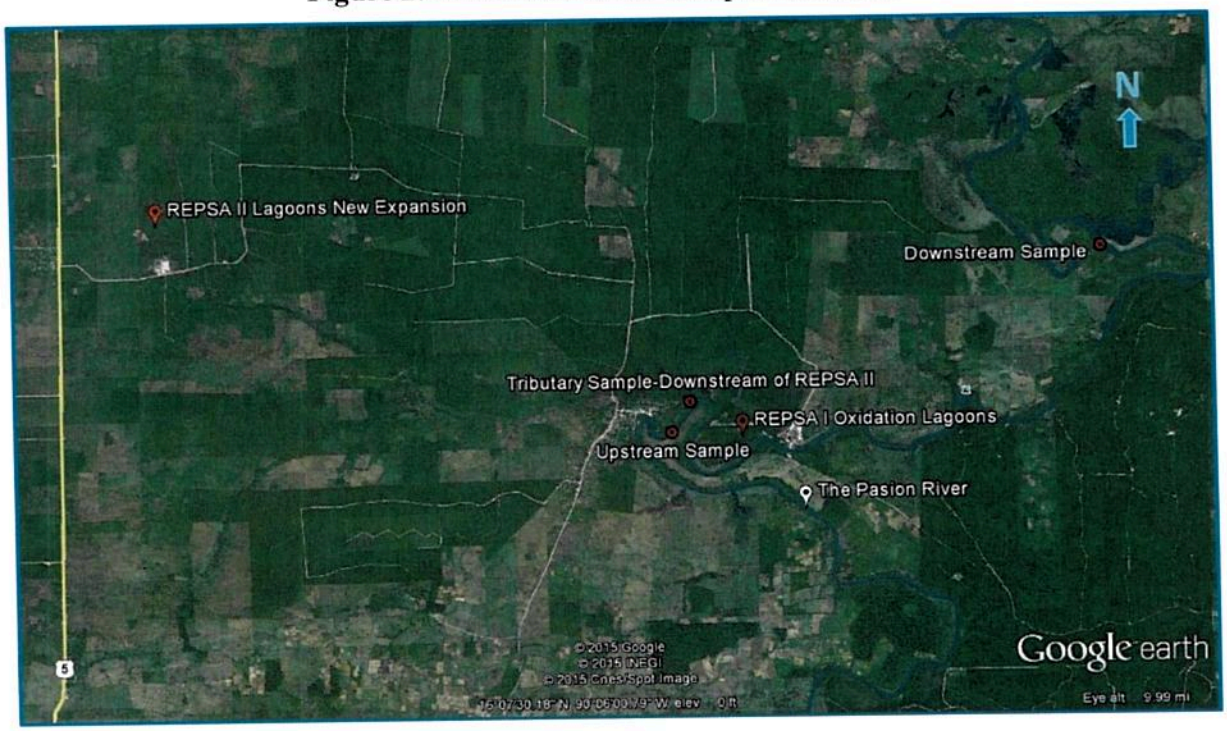


Table 2: EPA Field Measurements

	The Pasion River Field Measurements			
	Station ID	**River Downstream**	**Tributary**	**River Upstream**
	Sample ID	**Station 006**	**Station 007**	**Station 008**
	Matrix	**Surface Water**	**Surface Water**	**Surface Water**
	Sample Date/Time	**07/07/2015 12:00**	**07/07/2015 13:10**	**07/07/2015 13:30**
Analyte	**Units**			
pH	S.U.	7.75	7.74	7.72
DO	mg/L	5.72	5.72	5.56
Specific conductance (conductivity)	umhos/cm	302	306	301.9
Temperature	°C	26.83	27.07	26.62

EPA's field measurement results were similar in each of the sample locations.

MARN uses a multi parameter meter, a Thermo Scientific Orion A326 model, for field measurements. The meter measures pH, conductivity, and temperature. MARN recently acquired a dissolved oxygen probe to be used with the multi parameter meter.

4.2 Fish Kill Sampling Evaluation

The National Council for Protected Areas (CONAP) was the agency responsible for the direction of the collection of fishes after the fish kill. It is EPA's understanding based on a discussion with members of CONAP that there is no standard procedure for the investigation of fish kills. The method CONAP adopted in crisis was a modification of a graduate student work on the Pasion River studying the interactions between nutria and devilfish. It is believed that gill nets were used to collect fish specimens from the Pasion River and specimens were preserved in formalin and sent to the University of Florida for necropsy analyses. The methods utilized to investigate the Pasion River kill are not sufficient to be able to produce an accurate estimate of the number of fish killed nor determine the economic valuation of the kill. Furthermore, specimens that have been preserved in formalin may not provide sufficient evidence of the cause of death. Specimens should be frozen immediately after collection and then shipped to a lab for analysis.

EPA recommends the development of a fish kill investigation plan that includes a fish sampling protocol, economic valuation of the impacts and plans for prevention and/or remediation.

Note: Even though Malathion was mentioned as one of the suspected pollutants in the Pasion River fish kill and EPA recognized the potential pollution effects of this pesticide, the Malathion's analytical results were not shared with the EPA team. Consequently, the agency cannot formulate a technical opinion on this particular case. If the Malathion analytical results are provided, EPA will be available to present a technical opinion on this matter, if requested.

5 Conclusions and Recommendations

EPA recognized the professional experience and expertise of MARN inspectors and its well-developed inspections and sampling program. EPA recommends the implementation of an annual review program for the improvement of MARN's sampling program.

Sediments from the runoff of agricultural activities and wastewater from residential activities have affected the water quality of the Pasion River. In addition, unauthorized discharges of anaerobic wastewater/sludge into the river watershed by a palm oil processing company could create a negative impact in the aquatic life and human health of the Pasion River, moreover that the river is used by several communities in the nearby areas for drinking water, agricultural activities, irrigation, and fishing activities for human consumption. EPA offers the following recommendations:

- EPA recommends performing follow up sampling activities near the populated areas to protect human health. Sample analyses should include (but not limited) BOD_5, total suspended solids, total metals, ammonia, total phosphorus, pH, dissolved oxygen, temperature, *E. coli*, and fecal coliforms. *E. coli* is a species of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals. Studies conducted by EPA to determine the correlation between different bacterial indicators and the occurrence of digestive system illness at swimming beaches suggest that the best indicators of health risk from recreational water contact in fresh water are *E. coli* and enterococci. EPA recommends *E. coli* as the best indicator of health risk from water contact in recreational waters (USEPA, 2015).
- EPA strongly encourages the government of Guatemala to continue the review of existing Guatemalan wastewater regulations and perform the necessary amendments; for example, considering adding a limitation of dissolved oxygen into MARN's wastewater permits/discharge authorizations. Some of these efforts are already taking place through the assistance EPA provides to the CAFTA-DR countries under the environmental obligations of the US-Central America-Dominican Republic Free Trade Agreement. These actions will support the protection of the nation's water bodies by reducing potential pollutant that may impact human and aquatic life health. It will also provide MARN's inspectors the necessary tools to enforce their legal mandate of protecting the environment in a more effective and efficient manner.
- EPA also recommends the development of a national emergency management system that could outline the necessary steps to prepare, respond, and/or mitigate the impacts or risks of an emergency event. This plan should also describe the roles and responsibilities of the different agencies and other stakeholders that have jurisdiction in the emergency

response activities. The plan should also require specific qualifications and training of the personnel responsible to respond to such emergencies. In case of a future emergency, the plan will help the government to act with an organizational framework in place, with assigned responsibilities to each of the accountable agencies.

The Agency (EPA) is willing to consider requests for improving emergency management and other training materials associated with the effective implementation of the wastewater compliance program in accordance with the terms of the existing USEPA- USAID Inter-Agency Agreement, which supports environmental management assistance to CAFTA-DR countries.

6 References

APHA, AWWA, WEF, (2012). *Standard Methods for the Examination of Water and Wastewater. 22nd Edition*. American Water Works Association.

Gobierno de Guatemala (2006). *Acuerdo Gubernativo No. 236-2006: Reglamento de las Descargas y Reuso de Aguas Residuales y de la Disposición de Lodos.*

Khalid, A.R. & Mustafa, W.A.W, (1992). *External Benefits of Environmental Regulations; Resource Recovery and the Utilization of Effluents.* The Environmentalist, Vol. 12 No. 4, Pp. 277-285.

Madaki, Y.S., Seng, L, (2013). *Palm Oil Mill Effluent (POME) From Malaysia Palm Oil Mills: Waste or Resource.* International Journal of Science, Environment, and Technology, Vol. 2, No 6, 2013, 1138-1155.

MARN (2015). *Acciones realizadas por el Departamento de Recursos Hídricos y Cuencas, en la Microcuenca rio La Pasion, municipio de Sayaxche, departamento del Peten.* Informe No. 27-2015/DRHyC. Gobierno de Guatemala

USEPA, (2015). *Water Monitoring and Assessment: 5.2. Dissolved Oxygen and Biochemical Oxygen Demand.* http://water.epa.gov/type/rsl/monitoring/vms52.cfm

USEPA, (2015). *Water Monitoring and Assessment: 5.11. Fecal Bacteria.* http://water.epa.gov/type/rsl/monitoring/vms511.cfm

USEPA, (2015). *Malathion.* http://www2.epa.gov/mosquitocontrol/malathion

USEPA, (2002). *Wastewater Technology Fact Sheet: Anaerobic Lagoons.* Document EPA 832-F-02-009. Office of Water.

USEPA (2002). *Wastewater Technology Fact Sheet: Facultative Lagoons*. Document EPA 832-F-02-014. Office of Water.

USEPA (1977). *Aerobic Biological Wastewater Treatment Facilities: Process Control Manual.* Document EPA III-A-524-77. Office of Water.

USEPA Region 4 (2012). *Field Specific Conductance Measurement Operating Procedure*. Document No. SESDPROC-101-R5.

USEPA Region 4 (2013). *Surface Water Sampling Operating Procedure*. Document No SESDPROC-201-R3.

USEPA Region 4 (2013). *Wastewater Sampling Operating Procedure*. Document No SESDPROC-306-R3

USEPA Region 4 (2014). *Field Measurement of Dissolved Oxygen Operating Procedure*. Document No SESDPROC-106-R3.

USEPA Region 4 (2014). *Field pH Measurement Operating Procedure*. Document No. SESDPROC-100-R3.

USEPA Region 4 (2014). *Field Temperature Measurement Operating Procedure*. Document No. SESDPROC-102-R4.

Appendix A: Photographic Log

PHOTOGRAPHIC LOG

Photo taken by: **John Ruiz**	**Project Name:** **The Pasion River Fish Kill Investigation** **Technical Assistance**
Photo No: 1	**Date:** 07/07/2015
Direction Photo Taken: East	
Description: View of REPSA I's anaerobic lagoon where the bypass was observed. Lagoon was in full to capacity with a freeboard of approximately one foot.	

PHOTOGRAPHIC LOG

Photo taken by: **Jairo Castillo**	**Project Name:** **The Pasion River Fish Kill Investigation** **Technical Assistance**
Photo No: 2	**Date:** 07/07/2015
Direction Photo Taken: South	
Description: View of the bypass discharging anaerobic sludge into a ditch. The bypass was discharging sludge when EPA-MARN arrived at the plant.	

PHOTOGRAPHIC LOG

Photo taken by: John Ruiz		Project Name: The Pasion River Fish Kill Investigation Technical Assistance
Photo No: 3	**Date:** 07/07/2015	
Direction Photo Taken: West		
Description: View of the six-inch bypass with the valve closed.		

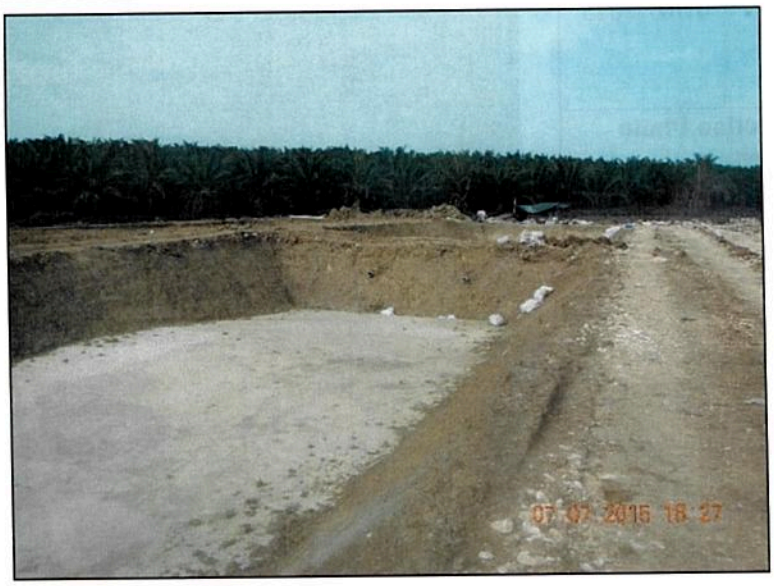
PHOTOGRAPHIC LOG

Photo taken by: John Ruiz		Project Name: The Pasion River Fish Kill Investigation Technical Assistance
Photo No: 4	**Date:** 07/07/2015	
Direction Photo Taken: South		
Description: View of the stagnant sludge on the ditch after REPSA personnel closed the valve.		

PHOTOGRAPHIC LOG

John Ruiz	**Project Name:** **The Pasion River Fish Kill Investigation** **Technical Assistance**
Photo No: 5 / **Date:** 07/07/2015	
Direction Photo Taken: East	
Description: View of the drainage channel of the bypass flowing toward the southwest. The Pasion River is located approximately 400 meters toward the south of the lagoon bypass location. Runoff flows downstream towards the river.	

PHOTOGRAPHIC LOG

Photo taken by: **John Ruiz**	**Project Name:** **The Pasion River Fish Kill Investigation** **Technical Assistance**
Photo No: 6	**Date:** 07/07/2015
Direction Photo Taken: North	
Description: View of REPSA II expansion of the oxidation lagoons treatment system. A concrete slab was observed at the bottom of each new lagoon.	

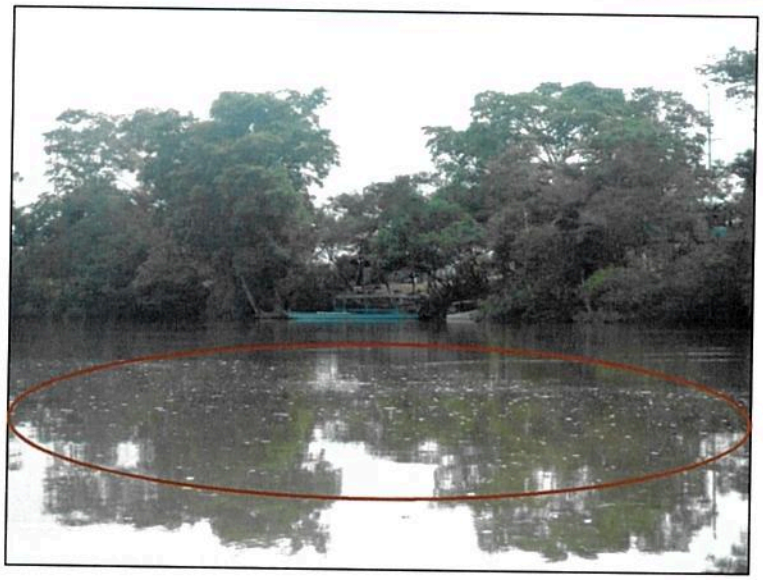
PHOTOGRAPHIC LOG

Photo taken by: **John Ruiz**	**Project Name:** **The Pasion River Fish Kill Investigation** **Technical Assistance**
Photo No: 7	**Date:** 07/07/2015
Direction Photo Taken: North	
Description: View of new anaerobic lagoon. REPSA I was transferring part of the wastewater to the REPSA II new plant.	

PHOTOGRAPHIC LOG

Photo taken by: John Ruiz	**Project Name:** The Pasion River Fish Kill Investigation Technical Assistance
Photo No: 8 / **Date:** 07/07/2015	
Direction Photo Taken: South	
Description: View of REPSA II's sludge digester lagoon (left) and final settling lagoon.	

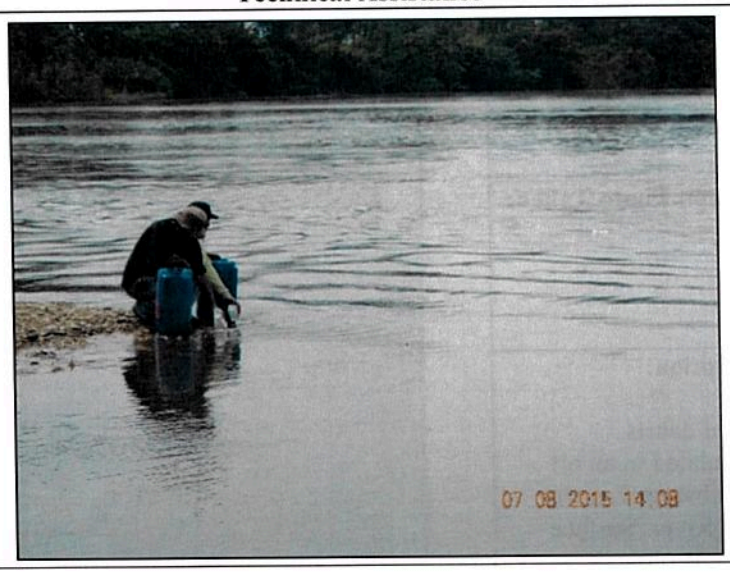
PHOTOGRAPHIC LOG

Photo taken by: Jairo Castillo	**Project Name:** The Pasion River Fish Kill Investigation Technical Assistance
Photo No: 9 / **Date:** 07/08/2015	
Direction Photo Taken: North	
Description: View of debris accumulated in an oil sheen observed on the Pasion River. Surface water was observed turbid.	

PHOTOGRAPHIC LOG

Photo taken by: **Jairo Castillo**	**Project Name:** **The Pasion River Fish Kill Investigation** **Technical Assistance**
Photo No: 10	**Date:** 07/08/2015
Direction Photo Taken: North	
Description: View of the sewage pipes seeping from the ground and flowing directly into the Pasion River. This was observed at the Sayaxche ferry area.	

PHOTOGRAPHIC LOG

Photo taken by: **John Ruiz**	**Project Name:** **The Pasion River Fish Kill Investigation** **Technical Assistance**
Photo No: 11	**Date:** 07/08/2015
Direction Photo Taken: West	
Description: View of collection of water for human consumption near the sewage pipes location.	

END OF REPORT